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"Mamatheya Thottilu" Real Time Baby Cradle with Smart Assistance using IoT

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***Abstract*— Baby care has become more crucial and difficult for working women in recent years. Working mothers will not have enough time to continuously monitor their children even at home. They either send their child to live with their grandparents or give the baby to a baby caretaker. A smart cradle with an automated baby monitoring system was developed in the proposed work. The essential infant parameters, such as temperature, heart rate, gas molecules, and the baby's motion and position, were measured and monitored in the baby monitoring system. The RaspberryPi board is used to connect the actuators and sensors together. The baby monitoring system will provide an incubator-like atmosphere for the infant. system is attached to the cradle. The baby is monitored round-the-clock by the baby monitoring system. The Internet of Things (IoT) aims to make life easier, and people are more likely to invest in things that make their lives easier. As a result, the number of IoT applications in various fields continues to rise. In order to speed up response times and provide parents with a greater sense of security, the Internet of Things (IoT) is incorporated into our baby monitoring system in this research work.**

Keywords: Smart Baby Cradle, Feature extraction, Face recognition, Sensors, Local binary patterns,

1. INRODUCTION

The number of working mothers in Industry and work from Home has skyrocketed in recent years. As a result, taking care of children has become a daily struggle for many families. As a result, the majority of parents send their children [1] to baby care homes or the homes of their grandparents. However, in either normal or abnormal circumstances, the parents are unable to continuously monitor their infants' health.if the sound of baby's cry is greater than a given present value, the baby will swing. For the value of y, the threshold level of a baby's cry is typically set at 35 decibels. The decibel level of the child's scream is between 30 and 40. Calculations are made for the amplified signal based on the voice input. After that, a digital signal is created from the amplified signal.

An automated baby monitoring system and smart cradle were developed. The essential infant parameters, The baby monitoring system measured and tracked things like the baby's temperature, heart rate, gas molecules, and movement and position. For connecting, the RaspberryPi [2] board is used. the actuators and sensors. In order to provide the baby with an incubator-like environment, The cradle is where the baby monitoring system is attached.. The baby is watched round-the-clock by the baby monitoring system.

The level of Noise exceeds the threshold value as normal, the sensor detects cry noise. The proposed cradle structure allows parents to give their children their full attention and bridges the gap between them and their child. The child receives sound, fundamental, and efficient support from the proposed framework[3]. The proposed system makes use of a sensor that detects the infant's movement by estimating infrared light from objects in its perspective. The temperature sensor can measure the temperature and send the information to the cloud, while the noise sensor can distinguish between noise and cry.

Due to the high cost of living, both parents are required to work at the moment. However, they must still look after their children, which add to their workload and stress. Parents who work can't always look after their kids. They either leave their children with their parents [4]or hire someone to look after them while they work. Because of safety concerns and costs, some parents do not want to hire a caretaker. Therefore, an IOT-based baby monitoring system and automatic swing system that can monitor the condition of the baby in real time are proposed solutions. The programmed child support can be used at home or in medical facilities. Infant care is beneficial for working guardians and medical clinics.

OBJECTIVES:

- To design a prototype of a smart cradle where it aims at monitoring the vital signs (cry detection, foul smell detection etc) of the baby by the data is obtained from the sensors.
- To keep track of the baby's activities and health conditions using appropriate sensors.
- To develop a mobile application that sends a notification to the parents with alarm and message.

2. LITERATURE STUDY

The main purpose of this study is to overcome the difficulties experienced by the mothers during the sleeping period of the babies and to put the babies to sleep in a comfortable and peaceful way as if the babies were in the mother's lap. In this direction, the motion that the mother made while sleeping her baby on the lap was modelled , and a cradle designed to repeat mother movements based on this model. In the modeling phase, ten subjects were experimented. A doll was given to the subjects and it was requested that to perform a baby rocking motion on their lap for 10 seconds. The performed motions[5][6] of the subjects were recorded with accelerometer of the mobile phone placed on the doll via an application (Accelerometer Analyser) compatible with the Android operating system. From the acceleration data, the motion trajectories of each subject were achieved through MATLAB. For this aim, firstly the noise in the data was filtered with moving average filter and then trapezoidal integration was applied twice to the filtered acceleration data. After that, the ideal route for the rocking motion on the lap was reached in consideration of the trajectories of the subjects. The mathematical model of the ideal route was derived by least square curve fitting method and the cradle following the mathematical model was designed in Solid works environment. At the end of the study a prototype cradle was produced.

This paper presents IoT based smart system that act as baby cradle monitoring system for engaged or working parent so that they can manage properly, and also for proper care and safety of the infant. The Raspberry pi B + module is used to have control on the entire hardware, condenser MIC is implemented for baby cry detection,
The proposed smart cradle system's method of operation is depicted shown in Figure. 1. Smart Cradle System Block Diagram The Smart Cradle System is shown in the block diagram above[7].

The various actions of a child are monitored by a number of sensors, including a noise sensor, a sensor, a sensor, and a camera module. who is forced to sleep in the cradle. A baby cradle that automatically swings with a motor when the baby cries is part of the system architecture. Additionally, The lullaby toy on the baby cradle can be remotely activated by parents through the server, and an external webcam can be used to monitor their infants' health.

The prototype of a baby monitoring system makes life easier for parents and caregivers alike by assisting them in time-sensitive tasks. It has been demonstrated that this baby monitoring system causes less harm to the most delicate babies. This monitoring system is a high-quality IoT-based real-time monitoring system with the best security measures.[8]

The child's temperature rises above a predetermined threshold, the sensor sends a text message to the parent with information about the child's body temperature. Additionally, a moisture sensor is included in the solution to safeguard the child's hygiene.[6]

3. METHODOLOGY

3.1 **Emotion Recognition:**

The facial expression recognition system is trained using the supervised learning method, by using images of various facial expressions. The system includes together with image acquisition, face detection, image preprocessing, feature extraction, and classification, the system also incorporates training and testing phases. Face images are used for detection of facial expression[9][10] and feature extraction, to separate the images into six classes corresponding to six fundamental expressions.

Image Acquisition

Static or image sequences are the types of images that are used for facial expression recognition. The camera can take pictures of faces. The mouth region is used to determine the emotion. The area of the mouth region is calculated by multiplying the number of pixels by the pixel width. The lowest and highest values for the mouth region area based on the emotions are listed in Table .1below .

Table 1: Baby Emotions categorization

Baby Facial emotions	Area of baby Mouth in mm	
	Lowest Value	Highest Value
Neutral	2	3
Smiling	10	16
crying	4	9

3.2 Face Detection

The detection of facial images is made easier with face detection. The Voila-Jones face detector Haar classifier is used to perform face detection on the training dataset, and Open Cv is used to implement it. The value of Haar-like features, which are connected black-and-white rectangles whose values represent the variance in average intensity across the image, is encoded by the difference between the total of black-and-white pixels' values.

3.3 Pre-processing of Image

Noise removal and normalization against pixel position or brightness variation are two components of image preparation. First the Color Normalization, and Histogram Normalization

3.4 Feature Extraction

The most crucial step in a pattern classification problem is choosing the feature vector. The face image is used to extract the most important features after pre-processing. Scale, pose, translation, and variation in illumination level are all inherent issues with image classification [6]. The Local binary patterns (LBP) algorithm, which is described in detail below, is used to extract the important features. Local Pattern of Binary LBP is the name of the technique for extracting features. By pointing each pixel with decimal numbers, the original LBP operator determines the local structure surrounding each pixel. LBPs or LBP codes are the names given to these numbers. The value of the center pixel is subtracted from the value of each pixel in a 3 x 3 neighborhood to compare it to its eight neighbors. Encoded negative values are with 0 in the result, while other values are encoded with following methods.

A binary number for that pixel is produced by combining all of these binary values in a clockwise direction, beginning with the neighboring pixel to the top left. The given pixel is then labeled with the binary number's decimal equivalent. The LBPs and LBP codes are the derived binary numbers.

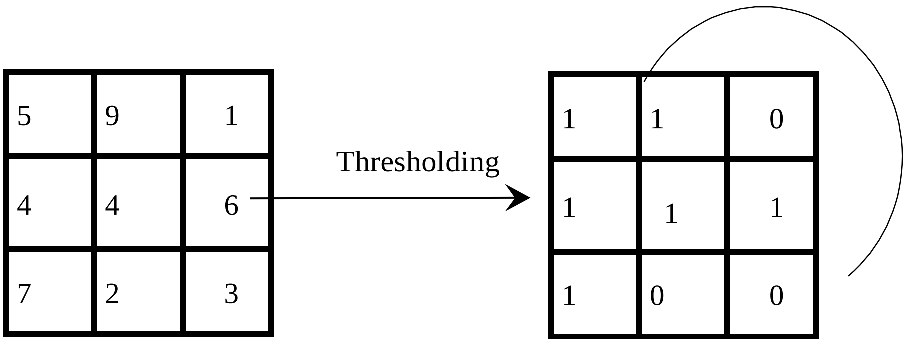

Figure 1 :The Basic LBP Operator

3.5 Convolution Neural Network (CNN)

From gaming and artificial intelligence to marketing and healthcare, facial expression recognition is a hotly debated topic. The classification of seven primary emotions into images of human faces is the objective of this paper. Before the final Convolution Neural Network (CNN) model was created, several models, including neural networks and decision trees, were tested. Due to their large number of filters, because they are able to capture the spatial features of the inputs, CNNs are better suited for image recognition[11][12] tasks. After making adjustments to the various hyper parameters, the proposed model had a final accuracy of 0.80. Two max pooling layers, two fully connected layers, and two six convolutional layers make up this structure.

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Hi=∑xa,ya I(f(xa,ya)=i),i=0,…,N–1-------(1)

Where N is the number of different labels produced by the local binary pattern operator using equation,
I(A)=1 A is true, 0 A is false---------(2)

The distribution of the local micro-patterns, such as edges, spots, and flat areas, across the entire image is depicted in this histogram. Additionally, spatial information should be retained by feature extraction for effective face representation. As a result, the face image is broken up into the ‘i’ small regions R0, R1,...,Ri using the following formula

Hi=∑xa,ya I(f(xa,ya)=i)I((xa,ya)϶ Rj------(3)

3.6 Classification

The classification of images shows how local micro-patterns like edges, spots, and flat areas of work are distributed throughout the entire image. Additionally, spatial information should be retained by feature extraction for effective face representation.

4. WORKING PRINCIPLE

The proposed system shown in Figure.1 uses a moisture sensor, a temperature sensor, and a sound sensor to detect wetness, temperature, and sound.The data from these sensors are either weak signal that are amplified through amplifiers or stored in the raspberry pi and processed[13]. In addition, the LCD displays the sensor values and the web camera provides live video surveillance of the infant. Live updates of the baby's conditions are provided by a Wi-Fi server unit through an app or a system with the assistance of cloud forecasting. The RF Transmitter, Receiver, Encoder Decoder, and Alarm of the buzzer unit are utilized to provide additional support. When the data that was sensed and compared to the data that was stored becomes abnormal, this unit is triggered and issues an alarm. Using web applications using Network, and controlled from any location in the world.

The baby's temperature, pulse, crying, and dampness are constantly monitored by a baby monitoring system controlled by the Internet of Things., which, in turn, sends control signals to the parents to let them know where the baby is. A built-in wi-fi module in an RaspberryPi microcontroller for remote surveillance is used in the design of this system, which also includes sensors like a temperature, pulse, gas, humidity, and camera, among others.

When a baby cries, the system begins playing the mother's voice automatically and continues until the baby stops crying.The controller is connected to a sound detector that uses its digital output to activate the device when the mattress gets wet, an alarm sounds. A temperature sensor that is kept under the bottom cover where the baby sleeps can continuously measure the temper send analog signals to the RL78 controller's
built-in ADC[14]. Digital data can be monitored continuously. The microcontroller-based system being developed aims to assist nurses and parents in infant care. The cover's wetness is indicated by a drop in temperature. When a baby cries, the system begins playing the mother's voice automatically and Figure 1: Working Model continues until the baby stops crying.
The following steps are used to monitor the baby condition:
• The controller is connected to a sound detector that uses its digital output to activate the device when the baby cries.
• When the mattress gets wet, an alarm sounds.
• A temperature sensor that is kept under the bottom cover where the baby sleeps can continuously measure the temperature and send analog signals to the RL78 controller's built-in ADC. Digital data can be monitored continuously. The cover's wetness is

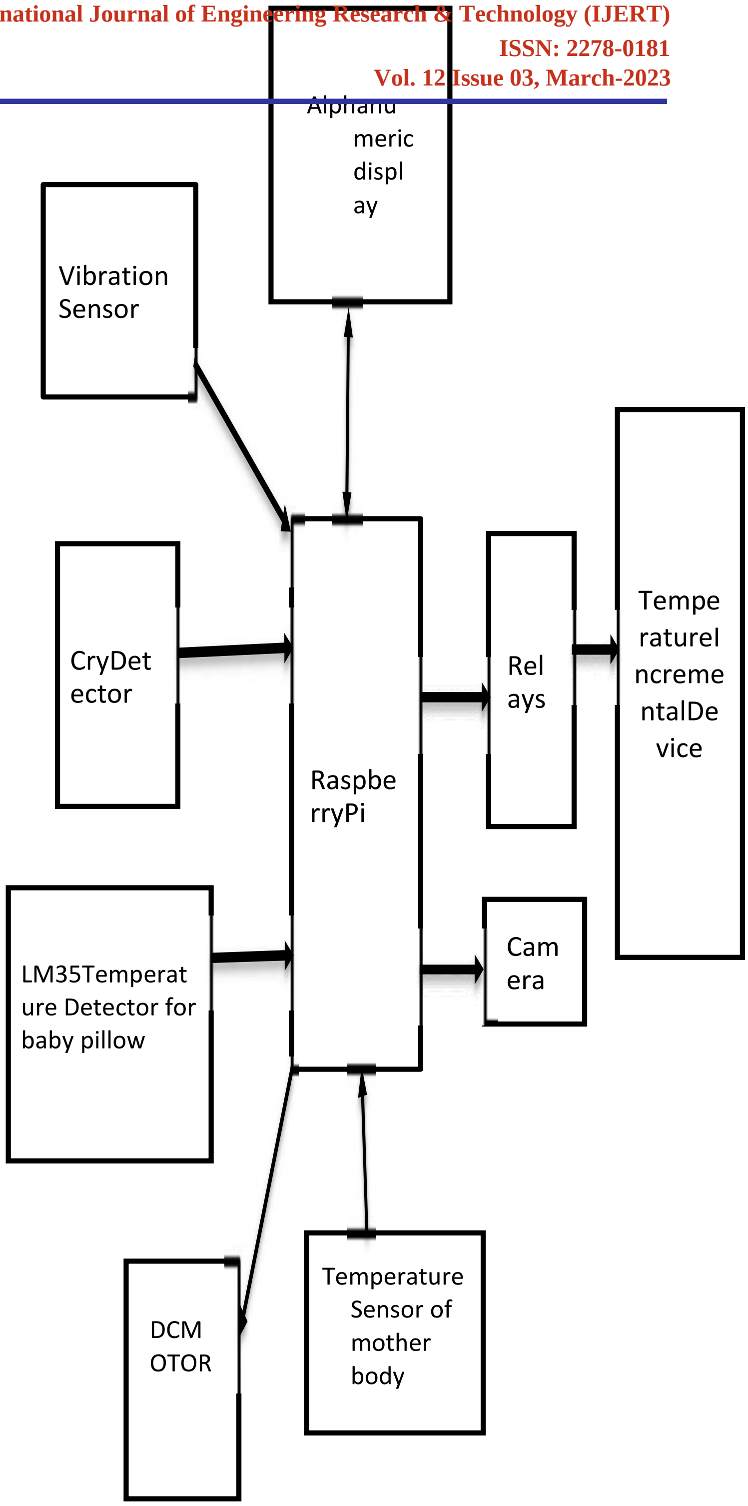


Figure 1: Working Model

indicated by a drop in temperature.

• The controller's cover can be changed by programming it to sound an alarm. Sounds alarm if the baby cries for longer than a predetermined amount of time, indicating that the baby requires care.

• To alert parents and nurses, a wireless interface sends an alert to Android-based phones.
• The controller is interfaced with an ALCD, which continues to display the status as messages.

• The cradle will swing whenever the baby cries.
• If a child is crying, the CNN algorithm is used to record the child's emotion and send a message to the parents.

The above steps are implemented using the following sensors :

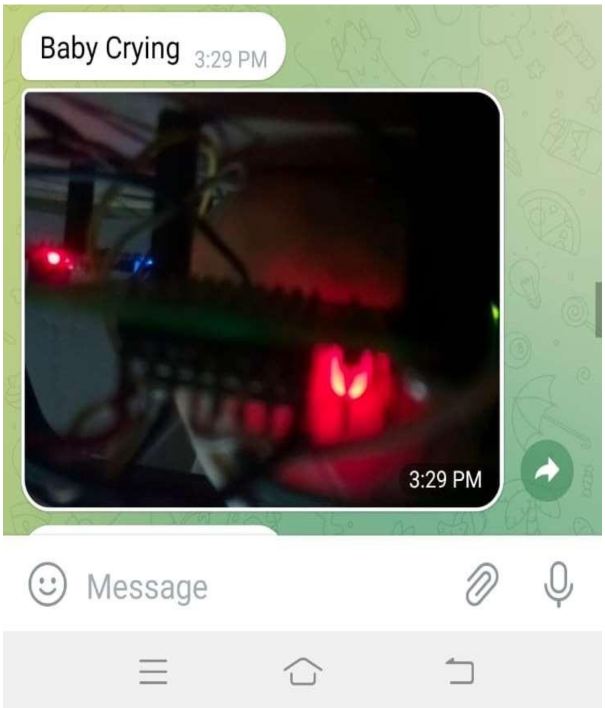
• Noise sensor: If the baby's cry exceeds the noise sensor's threshold value, an amplified signal is sent to the servo motor to automatically swing the cradle.

• Temperature sensor is used to measure the temperature and humidity of the cradle. The temperature sensor's primary goal is to ascertain the current temperature of the baby's surroundings. For instance, the parent can use the mobile application to swing the cradle, when the temperature reaches 22 degrees, which makes the baby feel uneasy.

• Flex Sensor: The child's movement within the cradle is detected by a sensor. For more precise data, the proposed model makes use of two sensors that are positioned in the extreme and opposite corners of the cradle. The mobile app receives the current status. Whenever the child moves to the right or left. The baby's movement in the cradle will constantly change if the baby is uncomfortably positioned there.

- Raspberry Pi Camera Module: The parent will be able to communicate with the child through the mobile application that is connected to the camera. The parent will be able to see the child live on the child's mobile application.

The screen shots of the results are shown in Figure 2 ,3 and 4.



. Figure 4:Baby Crying Screen Shot

5. CONCLUSIONS

This system was designed with working parents' comfort in mind. They may greatly benefit

Figure 2: Child Monitoring System

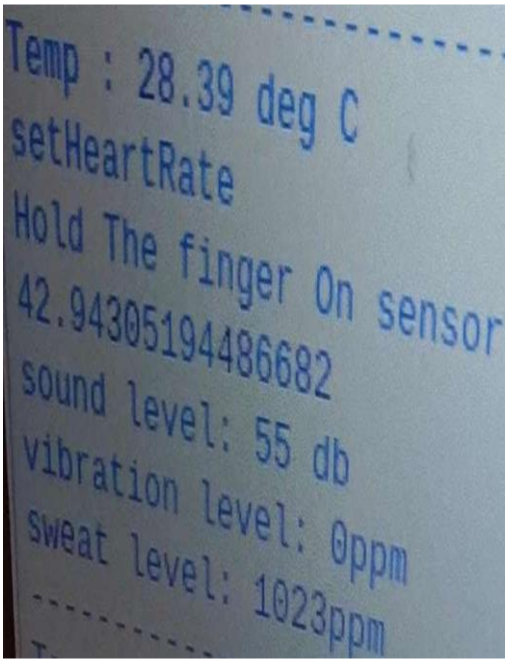


Figure 3: Detailed display of Child

from this system. Additionally, it enhances IOT usage. The technology can be used to make people feel more at ease and move faster. Parents may find a smart baby room to be a blessing. They are not required to pay for babysitters or maids. Because machines are more dependable than humans, they can rely on the system. To automate the cradle swing, we have incorporated a number of sensors into the model. The addition of new features to the cradle is made possible by the investigation of various kinds of sensors. In this study, the smart baby cradle system is developed. The additional features in the future to make it more user-friendly and efficient. The features that we can incorporate into this device, such as a musical toy that rotates Using an IP camera, and also implement continuous video streaming of the baby's activities. This will assist the parents in taking care of the infant even when they are not present. The technology of data science makes it possible to include additional sensors, such as those that can track sleep patterns and detect heartbeats. The research work carried out can be used to reduce parents' and nurses' workloads in hospitals and homes, respectively. This automatic baby cradle would enable a working mother to simultaneously care for her infant and perform household chores.

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